

EVALUATION OF TREE RISK IN THE SPRUCE-FIR REGION OF THE NORTHEAST

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In attempting to find possible means of combating recurrent epidemics of the spruce budworm^{1/} in the Northeast, research has shown that forest management has considerable promise. Reduction in the proportion of balsam fir to spruce and attainment of the highest possible proportion of rapidly growing trees are expected to result in a less severe outbreak and a higher percent of recovery following defoliation. These principles of silvicultural control have been discussed in detail by Graham and Orr (2)^{2/}, Balch (1), Westveld (5), and McLintock (3).

The recommended practice now being tested on a large scale in the spruce-fir region is a single tree selection system on as short a cutting cycle as possible--no longer than 25 years and preferably 15 or 20, or even shorter if feasible. This of course, means marking the trees to be cut; and it requires a considerable degree of care and skill

^{1/} The spruce budworm (Archips fumiferana Clem.) is a defoliator that feeds principally on balsam fir (Abies balsamea Mill.), white spruce (Picea glauca Moench.), and red spruce (P. rubens Sarg.). Epidemics seem to run in 30- or 35-year cycles, the last outbreak having been between 1910 and 1920. At that time, stumpage conservatively estimated at 100 million dollars was destroyed in Maine alone. The outbreak now devastating the forests of eastern Canada again threatens the Northeast.

^{2/} Numbers in parentheses refer to Literature Cited, p. 7.

in selecting the trees to be left for the next cut. Thus the need for a simple tree classification to enable rapid ocular evaluation of relative "risk" of spruce and fir of different size, age, and condition becomes immediately evident. While the decision to cut or leave a tree will often be clearly indicated by its size, presence of defect or damage, overmaturity, or some other obvious condition, there are as many borderline cases where more careful consideration of the factors that influence growth is called for.

An early attempt at such a classification was made on the basis of vigor as expressed by external features that were indicators of vigor--or growth rate--in the tree. Thus, a vigor I spruce or fir has a dense, well developed crown, usually--but not necessarily--symmetrical, with foliage and bark color typical of a healthy tree. It shows no evidence of disease or other damage and is making rapid lateral and terminal growth. Vigor II trees are usually of two types: those of good form and in apparently healthy condition, but making considerably less terminal and lateral twig growth than the vigor I; and those making good twig growth, but having rather thin, poorly developed or one-sided crowns. Vigor III trees are those with markedly poor crowns, whether because of slow terminal growth, overmaturity, sparse or yellowing foliage, trunk or crown deformity or damage, or any other physical manifestations of an unhealthy or dying tree.

Arbitrary limits of diameter growth for 5- and 10-year periods believed to coincide with these vigor classes were established, following examination of about 1,800 spruce and fir increment cores (4). Field checks were then carried out to determine the actual degree of correlation between appraised vigor and actual growth. It soon became apparent that one or two other factors often exerted more influence upon growth than the characteristics of vigor enumerated above. For example, since spruce and fir are both tolerant species, a tree with all the features of a vigor I but intermediate in crown class frequently had the growth rate of a vigor II. Similarly, a dominant or co-dominant with a high crown ratio often made diameter growth typical of a vigor I, although appraisal on the basis of external characteristics made it vigor II. It

was observed that the vigor characteristics were most dependable when applied to trees up to the point of maturity. As the trees reach maturity, the appearance of bark and foliage becomes less reliable as an index of growth. At the same time, the position of the tree in relation to sunlight (crown class) and the relative extent of its food manufacturing plant (crown ratio) exerted more influence upon growth.

Growth records confirmed the basic assumption that in general, on a given site, growth rate varies directly with the level of vigor, crown class, and crown ratio. Table I presents 5-year diameter growth averages measured on increment cores taken from 188 balsam fir and 300 spruce, classified according to the three criteria mentioned. For convenience, crown ratio has been expressed in whole numbers rather than percent (i.e., crown ratio of 4 means length of living crown is 40 percent of the total tree height), and has been divided into three levels, as indicated in the table.

Table 1.--Five-year diameter growth for spruce and fir, average by crown ratio, vigor, and crown class

Item	Red spruce	Balsam fir
	<u>Inches</u>	<u>Inches</u>
Crown ratio:		
High (7 - 10)	0.70	0.76
Medium (4 - 6)	.52	.60
Light (1 - 3)	.33	.39
Vigor:		
I	.59	.72
II	.51	.50
III	.33	.40
Crown class:		
Dominant and co-dominant	.58	.68
Intermediate	.43	.49
Overtopped	.36	.37

Table 2.--Five-year diameter growth for spruce and fir, showing interaction of crown class, vigor, and crown ratio

Vigor and crown ratio	Red spruce			Balsam fir		
	Dominant and co-dominant	Inter-mediate	Over-topped	Dominant and co-dominant	Inter-mediate	Over-topped
	<u>Inches</u>	<u>Inches</u>	<u>Inches</u>	<u>Inches</u>	<u>Inches</u>	<u>Inches</u>
Vigor I:						
CR 7 - 10	0.73	0.64	0.76	0.86	0.60	(1/)
CR 4 - 6	.61	.56	.38	.71	.57	0.55
CR 1 - 3	.51	.24	--	.54	--	--
Vigor II:						
CR 7 - 10	.67	--	--	.65	--	--
CR 4 - 6	.58	.41	.34	.58	.53	.37
CR 1 - 3	.44	.39	.33	.55	.46	.24
Vigor III:						
CR 7 - 10	--	--	--	--	--	--
CR 4 - 6	.60	.24	.15	.59	.37	--
CR 1 - 3	.30	.14	.14	--	.14	.12

1/ Blank spaces (--) indicate that data from fewer than 4 sample trees were not considered applicable.

However, in practice the concept of relative growth is associated with interactions of different crown classes with different levels of vigor, and with interactions of both of these with varying degrees of crown ratio. No one of the three taken individually provides as reliable an estimate of relative growth rate as all three considered as a complex. To permit evaluation of the relative rates of growth of two adjacent trees to determine which is the better risk, the combined values of the three factors must be considered. Thus, in table 2 diameter growth averages have been refined to represent each factor in terms of the other, and at each level.

The limited scope of the data, however, and the fact that no provision has been made for differences in growing sites, do not allow literal interpretation of the growth averages. The means can be accepted

and used in a relative sense only, and not as indices of absolute growth. This does not constitute a weakness in the present summary as only a relative evaluation is desired. The alinement of growth averages in both tables 1 and 2 merely confirms the original hypothesis that a dominant tree is generally a better risk than an intermediate, a vigor III a poorer risk than a vigor II, and so on.

It now remains to simplify this scale one step further to provide a rule quickly and easily applied in the field by the man with the marking ax or paint gun. At the present stage of our knowledge, it must be assumed that an equal influence upon growth is represented by the three variables: vigor, crown class, and crown ratio. Thus we may say that on the same site a vigor III fir, intermediate in crown class, and with a crown ratio of 7, can be expected to have approximately the same growth rate as a vigor I fir, overtopped, and with a crown ratio of 4. In other words, corresponding levels of each variable express the same relative growth rate. A simple rating system may be set up by which a tree is given from one to three points for its position in the scale of each of the variables, as follows:

Variable	Rating in points		
	3	2	1
Crown class	Dominant & co-dominant	Intermediate	Overtopped
Crown ratio	7 - 10	4 - 6	1 - 3
Vigor	I	II	III

The first tree mentioned above would be rated one point for vigor, two points for crown class, and three for crown ratio, a total of six. The second tree would be rated three for vigor, one for crown class, and two for crown ratio, again a total of six.

With this as a basis, all growth measurements were pooled for spruce and for fir, and each tree was rated according to the system just described. Then mean diameter growth was calculated by species for each numerical rating. The results are shown in table 3.

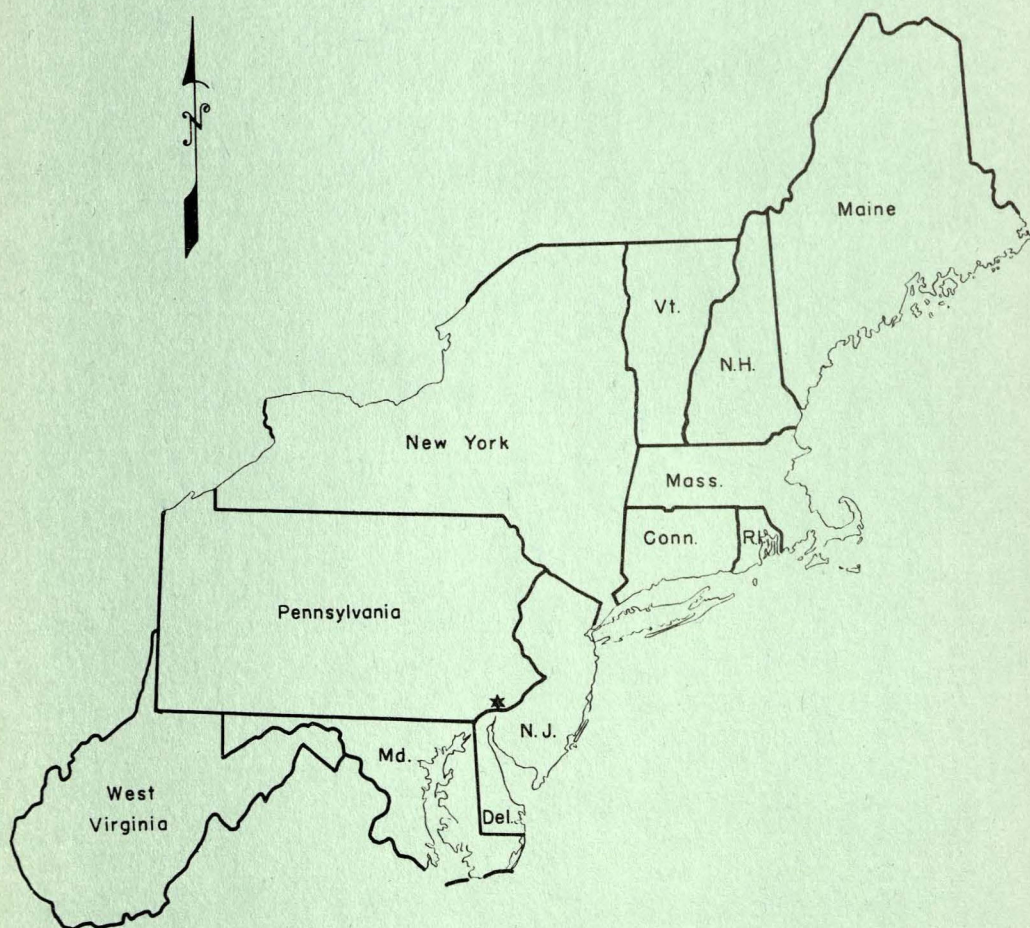
Table 3.--Five-year diameter growth for spruce and fir, based on composite rating of crown class, vigor, and crown ratio

Numerical rating	Balsam fir		Spruce	
	Trees	Mean growth	Trees	Mean growth
	<u>Number</u>	<u>Inches</u>	<u>Number</u>	<u>Inches</u>
9	21	0.86	17	0.73
8	56	.70	75	.62
7	43	.59	88	.59
6	31	.55	62	.44
5	25	.42	43	.31
4	7	.17	11	.19
3	5	.12	4	.14

It is again emphasized that a high degree of accuracy is not claimed for this rating scale, but the scale serves the purpose for which it was intended: to permit on a given site relative evaluation of tree risk, as expressed by growth rate, by means of three easily estimated variables. It is a working tool and guide for practicing foresters, timberland owners, and others who have occasion to mark spruce and fir for selective cutting.

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